only examples seen of any of the previously described Australian species—*D. palaeotropicus* Bernh., det. Bernhauer—do not agree at all well with *Dibelonetes* and are probably referable to *Sunesta* Blackwelder.

Besides the coloration, *D. rufoniger* differs from all other described species of the genus in the granulate sculpture of the elytra.

STILICODERUS ABERRANS, n. sp. (Text-figs. 10–12.)

Rather dull, the abdomen a little more shining. Body black, antennae, mouthparts and legs reddish-brown. Length: 7·25 mm.

Head about as broad as long, moderately convex, almost semicircular behind the eyes, the post-ocular region about one and two-third times as long as the eye (seen from above). Surface very finely and extremely closely punctured, the punctures to a large extent confluent, setiferous, the setae mostly very short but some longer, only the extreme apex of each antennal tubercle impunctate; on the sides, behind the eyes, the punctures are practically completely obscured by a fine, close, alutaceous ground sculpture, the whole of the undersurface of head with similar ground sculpture. Antennae not very long, reaching (if extended backwards) only to the middle of the pronotum, the first segment almost as long as the next two together, the second short, slightly longer than broad, the third longer, about one and one-third times as long as the second, the fourth to tenth decreasing gradually in length, the fourth a little shorter than the third, about one and two-third times as long as broad, the tenth very slightly transverse, the eleventh more than one and one-half times as long as the tenth, bluntly pointed apically, all the segments about equal in breadth.

Pronotum very slightly longer than broad, broadest in front of middle, strongly narrowed in front of the broadest part to neck with the sides almost straight, slightly narrowed behind the widest point with the sides lightly rounded, posterior angles rounded, base shallowly emarginate. Surface with punctures similar to those on head, on basal two-thirds with a very narrow, channelled, impunctate median line, superficially impressed on disc on each side of this line. Scutellum rounded behind, very finely and very closely alutaceous.

Elytra a little longer than broad, distinctly (about one and one-third times) broader than the pronotum, the sutural length about as long as the pronotum, broadest at about middle, the sides lightly rounded, the humeral angles rounded, the posterior angles rounded, the sutural angles obtuse so that the joint base is emarginate. Surface extremely closely, rugosely granulate, each granule bearing a small setiferous puncture.

Tergites of abdomen closely and extremely finely punctured and pubescent, the surface between the punctures with a close, fine, alutaceous ground sculpture.

♂.—Apical margins of the sternites of the seventh and eighth abdominal segments very shallowly emarginate over their whole length and fringed with close-set long setae. Aedeagus as in Text-figures 10, 11.

New South Wales: Acacia Plateau, 1 male (J. W. T. Armstrong).

Type in the collection of J. W. T. Armstrong.

Although this species agrees perfectly with *Stilicoderus* Sharp in the structure of the mouthparts, legs and thoracic sterna, it differs markedly from the other members of the genus in the sculpture and the length of the elytra. In these the pronotum is distinctly granulate, with the granulation extending on to the pronotum, and the elytra are markedly transverse, the sutural length much shorter than the pronotum, and the surface has a number of very large punctures arranged more or less in rows and between these fine setiferous granules. The humeral angles, although broadly rounded, are distinctly rectangular. In *S. aberrans* the pronotum is very closely punctured, without trace of granules, and the prosternum finely and closely alutaceous, the elytra are much longer and have no large punctures, but are closely, rugosely granulate. An undescribed species from New Guinea is in some ways intermediate between typical *Stilicoderus* spp. and the present species in that the elytra are somewhat longer, with the humeral angles obtuse, the elytral punctures rather less distinct with the granules less fine and much more numerous; the pronotum (and prosternum) is, however, granulate.

Blackwelder (1939, *Proc. U.S. Nat. Mus.*, 87: 107) places *Stilicoderus* Sharp as a synonym of *Stiliderus* Mots. (= *Psilotrachelus* Kraatz). Whilst there is no doubt that the two genera are very similar in general facies, there are so many small points of difference that *Stilicoderus* must be given at least subgeneric rank. In *Stiliderus* the labrum is differently formed, the sides of the head are strongly bordered below and the fourth tarsal segment is strongly bilobed.

THE OCCURRENCE OF THREE NEW WHEAT STEM RUSTS IN AUSTRALIA.

By I. A. Watson, Faculty of Agriculture, University of Sydney.

[Read 27th July, 1955.]

Synopsis.

The reactions of three new stem rusts of wheat are recorded. Each would be described as a different race on the accepted group of differential varieties. The first is race 21, which has been listed as race 21 Anz 1 to denote its presence in the Australia-New Zealand geographical area. It is characterized by the ability to attack seedlings and adult plants of Celebration. The significance of the other two, race 126 Anz 3 and race 222 Anz 4, has yet to be established.

Introduction.

Breeding for stem and leaf rust resistance is being carried out in the major wheat-producing countries of the world. It is recognized that for this work to be successful concomitant studies dealing with the variability of the two organisms *Puccinia graminis tritici* and *Puccinia triticina* must be undertaken. Results from different countries have clearly established the fact that new rusts occur from time to time and detection of them is facilitated by the screening action resulting from the commercial cultivation of varieties that serve as differentials.

Results of Breeding Rust-Resistant Wheats.

In Australia the occurrence of new races of rust following the release of resistant varieties has been reported in a number of cases (Watson and Waterhouse, 1949; Waterhouse, 1952; Watson and Singh, 1952). New types of *P. triticina* and *P. graminis tritici* have appeared. Gabo, initially resistant to rusts of both groups, became widely cultivated in 1944, and in 1945 leaf rust was found on it for the first time at Wee Waa, N.S.W. At present, Gabo is one of the most leaf rust susceptible varieties and it has been shown that a whole series of races are involved (Waterhouse, 1952; Watson, unpublished). In breeding work considerable use has been made of Hope resistance to leaf rust, and at Castle Hill, N.S.W., the derivatives Hofed (Federation × Hope) and Warigo (Hope × Nabawa) are extensively grown. In 1951 for the first time leaf rust was found on both varieties, but it appeared confined to this one area. During 1954–55, however, both varieties were rusted by *P. triticina* at widely scattered places in New South Wales. Here also no single race is responsible and, using seedlings of Renown, several rusts to which the latter is susceptible can be separated. These, on the basis of overseas work, are assumed to be virulent on adult plants of Hope derivatives. Spica (Kamburico × Three Seas) can also be mentioned with the other leaf rust material. This variety, while susceptible now, was initially resistant in Queensland, where it was developed (personal communication from Dr. L. G. Miles), but it has always been rusted in the field by *P. triticina* in New South Wales according to our observations since 1950. This can be explained by results which show that among the Australian leaf rusts are some that attack Spica while others do not. At present no commercial variety in eastern Australia is resistant to all races of leaf rust. Several resgenes have been identified, however, which are highly effective against the known pathgenes. The breeding procedure is well defined and is being carried out according to a predetermined scheme.

The evolutionary changes have been similar in the organism causing wheat stem rust. Eureka was made available in the late thirties, and in 1942 from Narrabri a stem rust designated 126B was found on it. Charter, Gabo, Yalta and Kendee increased rapidly in popularity in the mid-forties, but in 1948 they, too, fell to new rusts (Waterhouse, 1952). It was predicted that they would become susceptible simultaneously on account of their genetic relationship (Watson and Waterhouse, 1949). The complete details of all the stem rusts commonly occurring in Australia are given herein. Those of other rusts have already appeared (Waterhouse, 1952). In a study of these common rusts much attention has been given to the commercial varieties that have retained their resistance in spite of the major changes in the dominant rust flora. Until the 1954–55 season those considered to be resistant to all stem rusts in the field were: Celebration (Marquillo), Spica (Kamburico), Fedweb (Webster), Warigo (Hope) and Festival (Kenya 744 C6041).

Origin of the New Rusts.

There is no satisfactory explanation to account for the occurrence of these new rusts in either the leaf rust or the stem rust groups. There are several alternative suggestions. The role of the alternate host is well known, but in Australia this is probably only of minor importance. It is obvious that we must look for other causes and the work of Nelson and Wilcoxon (1954) needs further investigation.

In addition to the doubt concerning the mode of origin of these new types found in field collections, there is no proof to establish clearly that they are a recent development. There is a distinct possibility that they have been in existence for long periods. It may be that they are formed anew from the predominant types in each year of extensive rust development. In fact, if we agree that the changes in virulence are due to certain nuclear phenomena in the fungus, there is no reason to suggest that the rate of this change has been accelerated in the last thirty years, the period during which breeding for rust resistance has been in progress. All that has happened during this time is that the substrate has been repeatedly altered on a large scale, such that the virulence changes can be picked up with the sampling techniques adopted. It will be generally agreed that the sampling has been inadequate but under the circumstances it had to suffice. We have attempted to supplement it by growing specific indicator varieties at selected sites for observation. Except for showing the distribution of existing types this procedure has not helped to any extent.

Techniques for Detecting New Rusts.

In an earlier publication (Watson and Singh, 1952) it was suggested that the presence of certain rusts could pass unnoticed when using the techniques commonly employed in rust surveying work. We considered it useful to know the designation and distribution of the various races in a given geographical area, but we believed it more important to expose all available sources of resistance to as much rust as possible. In this way the breeding work could be more closely related to the rust survey studies. It is clear from our present knowledge that when the crosses that resulted in Eureka, Kendee, Gabo and Festival were planned, the respective resistant parents Kenya 743 (C6040), Kenya 745 (C6042), Gaza and Kenya 744 (C6041) should have been included in the set of varieties on which all rust collections for identification were placed. This would have given a greater opportunity to detect, if present, those rusts that have ultimately turned up to render susceptible Eureka, Kendee and Gabo.

Any procedure which enlarges the group of differential varieties increases the work and this must be weighed against the added information gained. We have done this and since 1952 seedlings of the following varieties have been included along with most of Stakman's varieties in the race survey work: Yalta, Eureka, Eureka × (Eureka × Gabo), Kenya 117A, Bokveld 1224, Khapli derivative 1451, Timopheevi derivative 1656, Agropyron derivative 1960 and Celebration.

From genetical studies something can be said of the genes possessed by certain of these varieties. Yalta has the resgene Kc_1 (Athwal and Watson, 1954) effective against the Australian rusts to which Gabo, Charter and Kendee are also resistant. Eureka has the gene Ka_1 which it has inherited from Kenya 743 C6040. Against certain Australian rusts this gene is highly effective, giving almost immune reactions at 60°F. As the temperature increases to 75°F. it becomes completely ineffective and thus to these same rusts Eureka becomes fully susceptible. Eureka × (Eureka × Gabo) is a line derived to help the spread of race 222BB in the field. It combines the genes Ka_1 and Kc_1 and hence is specific for those rusts attacking both Gabo and Eureka. It distinguishes between those epidemics caused by race 222BB alone and those caused by a mixture of races 126B and 222AB. Kenya 117A has the gene Kb_1, effective against all Australian stem rusts so far recorded. This gene appears to be allelic with the gene in Kenya 744 (C6041) which has been transferred to Festival. It may be identical with it (Athwal and Watson, 1954). Kb_1 appears to be allelic also with the gene in Egypt NA95 1228 (Athwal and Watson, unpublished). Bokveld has been included among the set since it is useful for the differentiation of rusts at high temperatures when Ka_1 is ineffective. From limited studies only the gene serving this useful purpose appears to be allelic with or closely linked to Ka_1, so that at low temperatures there is no segregation in crosses between Eureka and Bokveld. It is expected as a result of further work that a derivative of Bokveld may replace Eureka in this group of varieties. KD1451 has inherited two genes from Khapli Emmer (Athwal, unpublished) but they are not equally effective. TD1656 from Wisconsin, U.S.A., possesses two linked genes which have been effective against all Australian rusts recorded. AD1960 was derived by Dr. Shebeski in Canada, and to Australian rusts it appears to show the presence of several factors concerned in resistance. Celebration has inherited its resistance from Marquillo. It lacks the immunity factor possessed by Thatcher to those races unable to attack Kanred (Athwal and Watson, in press) and in general has a lower seedling resistance than Marquillo to the common rusts. Hope, while a useful parent in breeding, has not been found suitable for glasshouse work.

Designation of New Rusts.

The main details of the frequency of the various rusts determined in this work up to date will be given elsewhere, but during 1954–55 three new types were detected. The significance of two of them could have been overlooked in the absence of the results obtained on the sources of resistance. The relationship of these to the other common rusts detected during this period is shown in Table 1. As pointed out by Watson and Singh (1952), one set of differential genes would probably serve for the whole of Australia, and from Waterhouse's studies, extending over many years, it is likely that the same set would also serve New Zealand. Since there appears to be an interchange of spore material across the Tasman Sea, these two countries would constitute one geographical area. In view of this, it is proposed to specify the area from which these rusts came by using the letters Anz in their designation. Such a system would be in line with that commonly used elsewhere.

From Table 1 it will be clear that races 21, 126 and 222 have been found. The latter two can be subdivided into biotypes by the inclusion of the varieties given above. Thus there are three biotypes of race 126 and four of race 222. So far only one type of race 21 has been found, although the work on this is still unfinished. It is apparent from this table that under Australian conditions a study of the biotypes assumes greater importance than a study of the races, and this is inevitable since the genes present in the varieties of Stakman's set have played no part in the evolution of local stem rust resistant selections.

Of the eight rusts recorded in Table 1 it will be seen that all but three have been given designations by Waterhouse, and even race 21 has been recorded by him for Australia. However, as he does not give its reactions or varieties beyond Stakman's set it cannot be assumed to be identical with 21 Anz 1 and his culture was not available for comparison.

This rust 21 Anz 1, the first of the three new ones, is typical of race 21. It differs from the other two common Australian races, viz. 126 and 222, by its virulence on the *T. durum* varieties in the set at low and high temperatures. From the plant breeding viewpoint, however, its significance lies in the ability to attack Marquillo and Celebration, the latter being cultivated commercially and formerly being resistant to all Australian rusts. Although no rust capable of attacking Marquillo seedlings has been found previously, this is possibly because neither Marquillo nor Celebration has been included among the differentials. Race 21 gives an immune reaction on Kanred and, if it should be sent in mixed with 126 or 222, it could easily pass unnoticed, since the immune reaction on Kanred would not be evident.

During the 1954–55 survey, 21 Anz 1 was so widespread throughout eastern Australia that it must be concluded that this rust has been present for some time. Waterhouse recorded it first in 1948 from Kosciusko, and although it has not been found since it is possible that it has been on the increase. Very little rust was collected in 1953–54, when the writer first undertook this work, and race 21 was not among the types determined. It has only become obvious with the inclusion of Celebration among the differentials. Race 21 Anz 1 has been recorded most frequently from the southern portion of eastern Australia, but the following localities from which it has come indicate its widespread distribution:

New South Wales: Barmedman, Barham, Baradine, Curlewis, Corowa, Cowra, Forbes, Muttama, Narromine, Numba, Parkes, Scone, Tullibigeal, Uralla, Wagga, Wallendbeen, Walcha, Willow Tree, Woodstock, Young.

Queensland: Benowa, Warwick.

Victoria: Rutherglen, Lockwood, Longeronong, Burnley Gardens.

Tasmania: Launceston.

It has not been sent in from South Australia or from Western Australia.

TABLE 1.

Races and Biotypes of Puccinia graminis tritici *Detected during the 1954–55 Rust Survey on Stakman's Differentials, Australian Differentials and on Various Sources of Resistance.*

Race No.	Differentiating Variety.																					Water-house Designa-tion.
	Little Club.	Marquis.	Kanred.	Kota.	Arnautka.	Mindum.	Spelmars.	Kubanka.	Acme.	Einkorn.	Emmer.	Khapli.	Yalta.	Eureka.	Gabo × Eureka.[2]	Bokveld.	Kenya 117A.	AD 1960.	KD 1451.	TD 1656.	Marquillo.	Celebration.	
21 Anz 1 ..	4	4	0	3	4	4	4	3+	3+	;	;	;	;	;	;	;	2=	;	1+	x=	3	3+	—
126 Anz 1 ..	4	4	3	3	x	x	x	x	x	;	;	;	;	;	;	;	2=	;	1+	x=	;	x−	126
126 Anz 2 ..	4	4	3	3	x	x	x	x	x	;	;	;	;	3+	;	3−	2=	;	1+	x=	;	x−	126B
126 Anz 3 ..	4	4	3	3	x	x	x	x	x	;	;	;	3+	;	;	;	2=	;	1+	x=	;	x−	—
222 Anz 1 ..	4	4	3	3	x	x	x	1	1	;	;	;	;	;	;	;	2=	;	1+	x=	;	x−	222
222 Anz 2 ..	4	4	3	3	x	x	x	1	1	;	;	;	3+	;	;	;	2=	;	1+	x=	;	x−	222AB
222 Anz 3 ..	4	4	3	3	x	x	x	1	1	;	;	;	3+	3+	3+	3−	2=	;	1+	x=	;	x−	222BB
222 Anz 4 ..	4	4	3	3	x	x	x	1	1	;	;	;	3+	3+	3+	3−	2=	;	1+	3+	;	x−	—

In most cases the rusts from New South Wales were collected by co-operating farmers and on varieties other than Celebration. The samples from elsewhere came from research station workers. In those cases in New South Wales where rust was forwarded on Celebration plants it proved to be 222 Anz 2 and 3. At Myrtleford, Victoria, Mr. P. H. Debrett found rust on Celebration but none on Thatcher and, although no viable uredospores were available, these readings probably indicate that 21 Anz 1 was present, since Thatcher is known to possess the immunity factor to rusts of this type (Athwal and Watson, in press). Moreover, adult plants of Celebration have been found to be susceptible in the glasshouse to this rust. It will be seen from Table 1 that several sources of resistance are still effective despite this new rust. Ka_1, Kc_1, Kb_1 are all useful and the genes of KD1451, TD1656, AD1960 and probably Hope can still be of value.

The second new rust, 222 Anz 4, may turn out to be of less practical importance than the first. It is closely related to race 222BB (222 Anz 3) already described by Waterhouse, and it may have arisen from it. The material which carried this rust came from Richmond, N.S.W. At this centre a heavy stem rust epidemic caused almost entirely by 222 Anz 3 had been created artificially in an isolated area by inoculation of spreader rows with a pure culture.

Genetic material of the cross Eureka × TD1656 was being studied under this epidemic. Crosses in which TD1656 is the resistant parent usually show a two-class